



Coastal Engineering

Technical Note



PHYSICAL MONITORING OF NEARSHORE SAND BERMS

PURPOSE: To provide information that can be used for planning a physical monitoring program of contour-parallel nearshore sand berms.

INTRODUCTION: Nearshore berms constructed of clean, sandy, dredged material are becoming more popular as Districts and other agencies realize their potential benefits. Monitoring of these berms is necessary to ensure the berms are constructed properly and assess their behavior.

A nearshore berm consists of dredged sand placed in a long mound in shallow water (usually less than 25 ft), often parallel to shore or bottom contours. Typically they are constructed from maintenance dredged sand using split hull hopper dredges and are 4 to 10 ft above surrounding topography, 400 to 700 ft wide at the base, and over 5000 ft long. Nearshore berms have several advantages over conventional offshore disposal. Often, placing sand closer to the inlet from which it was removed may be cheaper than sand disposal in designated offshore sites or directly on the beach. For example, costs per cubic yard for the various disposal options from Fire Island Inlet, NY, were:

| Beach Nourishment | Historical Disposal Site | Nearshore Berm |
|----------------------|-----------------------------|-------------------|
| \$5.50 (bid) | \$4.00 (estimated) | \$2.23 (actual) |

Nearshore berms also have potential benefits for beaches. Since the berm forms a bar-like feature, it can dissipate incident wave energy by inducing wave breaking. As the berm disperses over time, it contributes quality sand to the nearshore system. The berm may also act as a partial block to the loss of beach materials to deeper water during storms. A nearshore berm may also move onshore, contributing visible amounts of sand to the dry beach. In this case, the nearshore berm can be termed a feeder berm. However, the research and field experience to define the combinations of sediment characteristics and environmental conditions necessary for onshore movement of sand are not complete. Therefore, the term nearshore berm, which only describes where the feature is placed without inferring its ultimate contribution to the littoral system, is generally preferred.

Physical monitoring of nearshore berms involves measuring changes in mound elevation and volume through successive bathymetric surveys. Most monitoring plans should also include taking sand samples along the berm and possibly on the beach to measure changes in grain size. Beach profiles are often taken to investigate profile changes in response to the nearshore berm. Because experiences with nearshore berms are limited, design guidance is not yet available. Consequently, measurement of the driving forces--waves and currents--have been included on some of the projects.

Physical monitoring is needed to more directly quantify the physical benefits of nearshore berms, verify performance, and check construction. This technical note summarizes the monitoring plans used for several nearshore berms and suggests monitoring recommendations for nearshore berms in general.

MONITORING PROGRAMS FOR EXISTING NEARSHORE BERMS: During 1987, three nearshore berms were constructed by Corps FOA's; one off Sand Island, AL, and two along the southern shore of Long Island, Gilgo and Lido Beaches, NY (the Lido Beach project is not discussed here for lack of available information). Hands (in preparation) discusses interim monitoring results for the Sand Island nearshore berm. See McLellan, Truitt, and Flax (1988) for detailed information on the Gilgo Beach nearshore berm. A nearshore berm was completed off South Padre Island, TX, in January 1989. Monitoring procedures for each project are summarized in Table 1.

GENERALIZED NEARSHORE BERM MONITORING GUIDELINES: The following generalized nearshore berm monitoring guidelines have been synthesized from the experiences and recommendations described above. Since the number of berm projects is limited and data analysis continues, modifications to these recommendations are likely. The most important recommendation is to begin the initial monitoring phase as soon as possible after construction is completed. Shallow placement of the berms makes them particularly susceptible to rapid sediment dispersion.

Berm Position Bathymetry: Bathymetric surveys are the backbone of nearshore berm position monitoring, providing volume and elevation change information, and should be included on all projects. Survey lines should be run perpendicular to the berm alignment at a 200-ft spacing, continuing from the breakers, across the berm, out to closure depth. This closure depth will typically be from 20 to 30 ft on the East and Gulf Coasts, and 30 to 45 ft on the West Coast. To date, no nearshore berms migrated onshore intact. Instead they have generally dispersed or spread with the major movement being in the alongshore direction. Therefore surveys should extend from a minimum of 500 to 1,000 ft updrift of the berm to 1,000 to 2,000 ft downdrift. Pre-construction, immediate post-construction, and quarterly surveys thereafter are recommended, with a minimum of surveys twice per year, e.g. late winter/early spring (March/April) and late summer/early fall (September/October).

Fathometer surveys should be of high quality since errors in volumetric estimates associated with survey errors of ± 0.5 ft are large. Microwave positioning is a must. Tide corrections, based on a nearby open water tide gage if possible, are also required, as are vessel squat and speed of sound corrections. Clausner and Hands (1988) and Fredette et al (in preparation) discuss these surveying and positioning factors in greater detail.

There is often an opportunity to use the final construction acceptance survey as the initial monitoring survey. If surveys are to be performed by a combination of district FOAs and private contractors, data compatibility and consistency must be assured. This is particularly true if volume change and elevation data will be analyzed by computer.

Table 1
Summary of Nearshore Berm Monitoring Activities

| Monitoring | Projects | | |
|--|--|--|---|
| | Fire Island/ Gilgo Beach, NY | Brazos-Santiago/ Padre Island, TX | Mobile Bay/ Sand Island, AL |
| <u>Surveys</u> | | | |
| Hydrographic Surveys of Nearshore Berm | 100 ft spacing between lines. Pre-, mid-, post-, 1 mo, every 2 months. | 500 ft spacing between 14 lines, each 3500 ft. Pre-, post-, 1 mo, quarterly. | 200 ft spacing between 42 lines, each 2000 ft long. Pre-, every 2 weeks for 2 mo, every 2 months. |
| Beach Profiles | 500 ft spacing. Pre-, mid-, post-, quarterly. | 1000 ft spacing, 11 lines. Post-, 6 mo, 12 mo. | None |
| <u>Sediment Samples</u> | | | |
| Nearshore Berm | Pre-, post-, 2 mo. | 12 grab, 6-10 cores. Per survey. | 31 grab, min. 200 ft apart. Per Survey. |
| Beach | Pre-, post-, 2 mo. | Undetermined. | None |
| <u>Waves/Currents</u> | LEO | LEO | Nearshore wave/current gages Offshore wave/meteorological |
| <u>Side-scan Sonar</u> | None | None | Pre-, two post-surveys. |
| <u>Seabed Drifters</u> | None | Bundles released from 4 sites, each survey. | Bundles of 50 released from 6 sites, each survey. |
| <u>Aerial Photography</u> | Pre-, post-, 3 mo. | Post- 1 additional. | 2 mo, 7 mo. |
| <u>Characteristics</u> | | | |
| Length (ft) | 7,500 | 5,300 | 8,000 ft |
| Width (ft) | 500 | * | 500-700 ft |
| Elevation (ft) | 1-9 ft, 4 ft avg | * | 6-8 ft |
| Amount of Material (cu yd) | 420,000 cu yd | 225,000 cu yd | 464,000 cu yd |
| Water Depth of Base | -16 ft mlw | -22 to -19 ft mlw | -19 ft mlw |

* This information still unavailable pending analysis of monitoring data.

Beach Profiles: The need for beach profiles will be a function of the purpose of nearshore berm. If the nearshore berm is intended to provide beach protection or nourishment, then beach profiles will be needed to quantify the effects. As the water depth in which the nearshore berm is constructed increases, probable short-term effects on the beach will decrease, reducing the need for frequent beach profiles. If the nearshore berm is being placed strictly to save money by reducing haul distances and is being placed where beach erosion is not a problem, beach profiles may not be needed. Nonetheless, potential claims of adverse effects due to the berm probably make it prudent to take a limited number of pre- and post-construction profiles.

Beach profiles with 500-ft spacing should be adequate for most projects. These profiles should be taken at the same frequency as bathymetry if possible and should extend updrift and downdrift of the berm the same distance as the bathymetric profiles. To aid in identifying the benefits of a berm, a control section of the beach, some distance away from the berm with similar erosion history, should also be surveyed. This may also help avoid claims of adverse effects.

Sea-sled surveys (Clausner, Birkemeier, and Clark 1986) are a highly accurate alternative to Fathometer surveys (average sled vertical envelope ± 0.1 ft vs 0.5 ft for Fathometer). One advantage of sled surveys is that they can measure the profile through the surf zone. In many cases, sled survey lines can easily extend from the subaerial beach seaward across the nearshore berm out to closure depth, allowing simultaneous monitoring of the entire profile.

Sand Sampling: Sand samples should be taken and analyzed to help determine migration of the berm. The usefulness of this tracer technique will be reduced if grain size distributions of the nearshore berm and native material are similar. Ten samples per mile of berm, with the samples distributed between the crest and flanks should be sufficient. Samples should be obtained during the bathymetric surveys if possible to correlate elevation changes with changes in grain size. Grain-size analysis using 1/4 phi sieves should be obtained for each sample. Control samples from adjacent areas would provide a measure of natural variability.

Short cores can be taken to show depths to which sediments are being worked by waves and currents. Cores can be X-rayed to show sediment reworking and sub-sampled for grain size analysis at different elevations. This level of monitoring is not recommended for most nearshore berm projects due to cost.

Waves/Currents: From a research perspective, measurements of the forces driving movement of nearshore berms is very desirable, but quality long-term measurements of waves and currents are very expensive. Ideally, directional wave and alongshore current measurements would be taken both on the seaward and landward side of the nearshore berm. This should produce data on wave height reduction due to the nearshore berm, modification of wave direction due to refraction over the berm, and changes and in alongshore/cross shore currents due to the berm.

The cost of installing and maintaining instruments, combined with data analysis costs, make these coastal process measurements practical only for a

limited number of research efforts, such as Sand Island. In addition fishing/shrimping activities make it difficult to protect gages.

Littoral Environment Observation (LEO) measurements are a low cost alternative to instrumentation. However, data only allow qualitative estimates of wave height, direction and alongshore currents. Training, supplies, and processing LEO data cost approximately \$3,000 for the first year, and \$2,000 per year for subsequent years.

Sea Bed Drifters (SBD): SBD's are umbrella-shaped, near-bottom current drogues. They are perhaps more useful as devices to help site berms, but can be used on existing nearshore berms to provide insight as to direction of prevailing bottom currents. In addition, public involvement in return of the drifters can result in good, low cost, public relations. McLellan and Burke (in preparation) describe in detail an SBD study used to site the Brazos-Santiago Pass/Padre Island nearshore berm. Clausner (1988) has details on actual use, and Hands (1987) has a review of earlier deep-water SBD studies.

Aerial Photography: Aerial photography is standard practice for many monitoring projects. It is not very expensive and gives a continuous picture of the beach. While beach profiles provide much more accurate information on changes, aerial photography can, at low cost, provide information on beach changes for miles beyond the project boundaries. Use of aerial photography to directly monitor the berm is limited to cases of exceptionally clear water or very shallow berms (less than 4 ft).

It is recommended that aerial photography be included in nearshore berm projects. Aerials should be flown at least twice a year at times coinciding with profiles and surveys if possible. Color photography is recommended at a maximum scale of 1:4,800.

Side-Scan Sonar/Subbottom Profilers: Side-scan sonar produces an acoustic picture of the bottom. Based on experiences at Sand Island, it is not recommended for monitoring nearshore berms in general. Subbottom profilers are considered primarily a research tool and are not recommended for use in berm monitoring studies at this time. Both of these instruments are discussed in greater detail in Clausner and Hands (1987).

Diver Observations: Diver observations are probably not required for general nearshore berm monitoring. Divers can give information on small scale processes and biological activity, take short cores, and maintain bottom instrument packages. However, their expense is probably not justified for most projects.

Wind: Wind data may prove useful in conjunction with nearshore current observations, and is often useful in interpreting SBD movements. If it appears that wind data should be used in interpreting nearshore berm performance, availability of wind data from local airports, the National Climatic Data Center, and local Coast Guard Stations should be checked.

ADDITIONAL INFORMATION: Contact Mr. James Clausner (601/634-2009) or Mr. Fred Anders, (601)634-3043, of the Coastal Structures and Evaluation Branch.

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